# Developing an understanding of the concept of AREA

**TRACEY MUIR**

provides insight into the types of experiences needed to establish a sound understanding of area measurement in middle primary years.

When asked to calculate the area of a particular shape, one student responded by asking, "Is that the outside or the inside?" while another student replied, "I think it's the one where you put a little 2 next to it." Both of these responses indicate a lack of conceptual understanding of area and reinforce the research findings that students commonly confuse area and perimeter and that many elementary and secondary school students have an inadequate understanding of area and area measurement (Outhred & Mitchelmore, 2000; Zacharos, 2006). This article describes a learning sequence undertaken by the author with a grade 3/4 class which focused on developing an understanding of the concept of area and was consistent with Tasmania's curriculum documents which advocate that the core content for Standard Three should introduce students to area by covering shapes and objects (Department of Education, 2007). The recommended structure for teaching measurement topics up to, but not including formula or application, (Booker, Bond, Briggs & Davey, 1998; Van de Walle, 2007) was incorporated into the learning sequence.

## Perceive and identify the attribute

Area can be defined as the surface covered by any 2D shape (O'Brien & Purcell, 2006) and early learning experiences should help students distinguish size (of

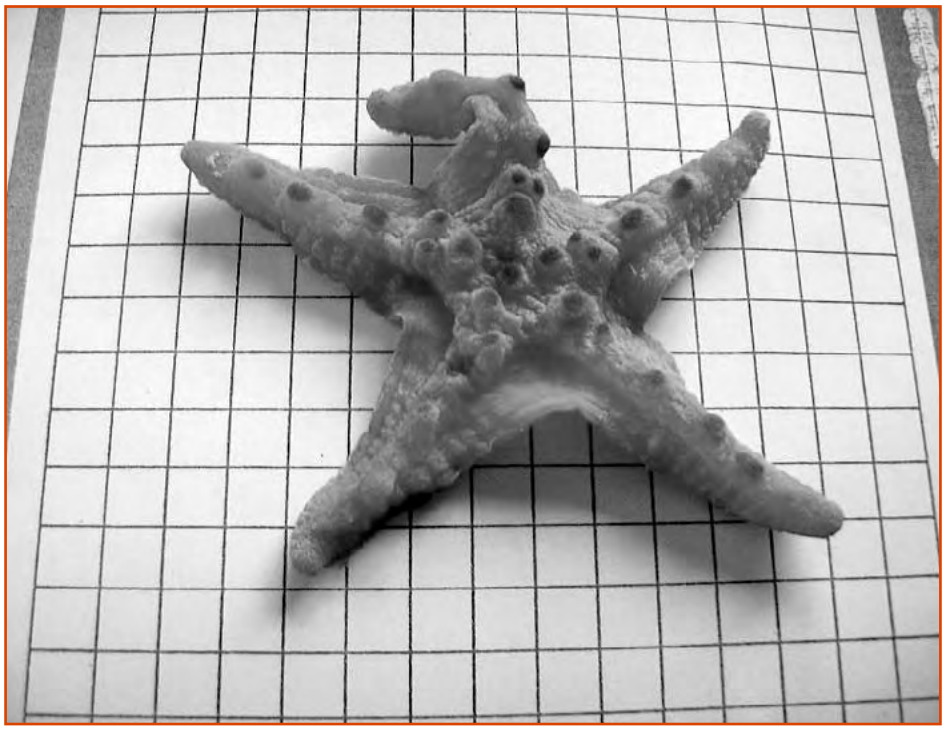

Figure 1. The growing starfish.

area) and shape, length and other dimensions (Van de Walle, 2007). In order for the students to conceptualise the nature of area and as a means for motivating students to engage with the topic, I introduced the learning sequence by showing the class a "growing starfish" (a variety of different "growing creatures" are available from novelty shops and markets). The labelling on the package claimed that the starfish would increase 600% in size when placed in water for 72 hours. As a class, we decided to investigate whether or not this claim was valid. Purposeful discussion occurred around the terms size, length, percentage and how best to measure the starfish. In order to maintain the focus on area, I presented the students with one centimetre grid paper and asked how it could be used to monitor the starfish's growth. It was decided that each day a student would trace around the starfish on to the grid paper. After three days, the starfish should have reached its maximum size.

The picture book *Zack's Alligator* by Shirley Mozelle would provide an additional source of motivation to engage students in conducting the investigation.

## Comparing and ordering

Each day the starfish was "measured" and traced on to the grid paper (see Figure 1). Comparisons of area were made informally at this stage (i.e., no exact measurements were calculated by counting the number of grid squares), but students could see that the starfish was "growing" each day. To complement the investigation, explicit teaching activities were also conducted to further identify area as an attribute and to provide opportunities for comparing and ordering different areas. Students compared three different shaped birthday cakes, for example, to identify which one would have the most space on top for icing. Tangrams and pattern blocks were used to determine students' conservation of area.

## Using informal units

Throughout the sequence, students had the opportunity to use both non-uniform units (e.g., hands, lima beans) and uniform units (e.g., tiles, dominos, paper, cards) to measure area by covering surfaces and counting how many of each unit were used. Engaging in such tasks can lead students to appreciate the usefulness of standard units when it comes to communicating their findings to others (Department of Education and the Arts, 1994). The focus at this stage was still on developing the concept of area as a measure of covering, and encouraging students to use estimation prior to measuring. One

specific activity involved students selecting from a range of materials and posing "area riddles" for others to solve (see Figure 2).

Important measurement principles, such as the need to cover surfaces without leaving gaps and that the unit must remain constant, were emphasised throughout these activities (see Figures 3 and 4).

The advantage of using arrays was also explored. One student realised that he did not need to completely cover his desk with cards to determine the area; instead he could "count how many cards in the top row and times it by how many along the side" (see Figure 5).

| | |
|---|---|
| I have an area of 6 playing cards.<br><br>What am I?<br><br>(lift flap for answer) | Answer<br><br>The dictionary cover |

Figure 2. Area riddle.

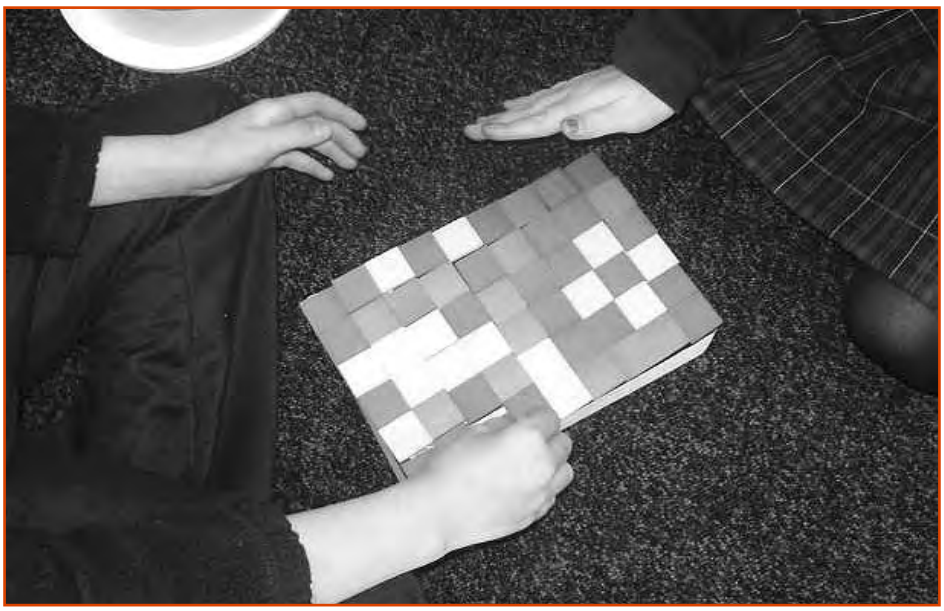

Figure 3: Tessellating tiles were used to emphasise the importance of leaving no gaps.

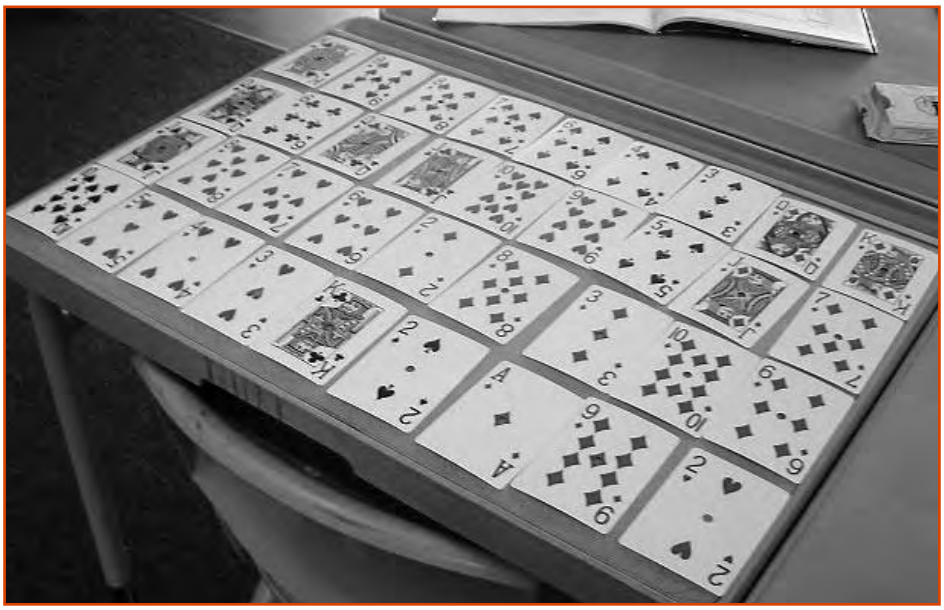

Figure 4. Playing cards brought out the understanding that the unit (and orientation) must remain constant.

## Formal units

After five days (we wanted to be sure that the starfish had finished growing!), we looked at the tracings made on the grid paper. After some discussion it was decided that we could measure how much the starfish had grown in area by counting the squares. As the starfish was an irregular shape, there were part squares that needed to be counted. According to Van de Walle (2007) students in grade 3/4 should begin to wrestle with partial units and mentally put together two or more partial units to make one whole; measuring the area of the starfish provided students with this opportunity. Maintaining an accurate count of the partial squares, however, proved to be problematic, until one student suggested colouring the partial squares in matching colours (see Figure 6).

Figure 5. Ben used his knowledge of arrays to more efficiently calculate the area of his desk.

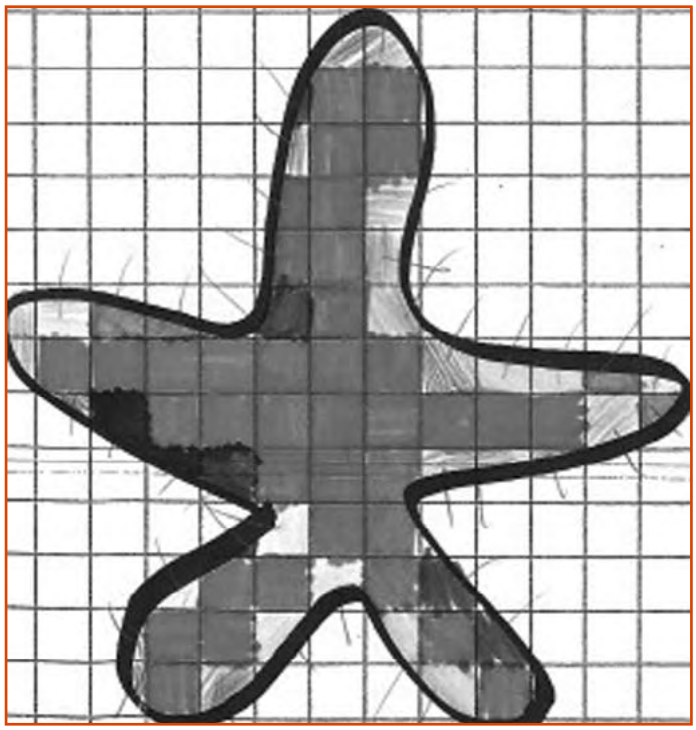

Figure 6. Colouring partial squares to make up whole squares.

The original starfish was calculated to be approximately 44 squares, while the "grown" starfish was approximately 204 squares. If our calculations were correct, the starfish should have grown to 308 squares; our starfish grew almost 400% or five times its original size.

The aim of the learning sequence was to introduce students to the concept of area as an amount of surface through the provision of experiences that primarily involved covering surfaces. I was pleased with the level of understanding shown by most students, and while some may arguably have been ready for more extensive investigations, the covering activities revealed a lack of understanding of the multiplication process and I decided to focus future teaching direction on this process, with the intention to revisit area later in the term.

## Measurement sense

Students' approaches to estimation and their participation in the tasks revealed that many seemed to lack "measurement sense" in that they did not make reasonable estimates or seem to have an appreciation of the usefulness of estimation (Muir, 2005). Number sense, or the ability to use numbers and quantitative methods to communicate, process, and interpret information (McIntosh, Reys & Reys, 1997), is recognised as being essential to participate "numerately" in society (Department of Education, Tasmania, 2003). It is equally important to develop "measure-

ment sense" in students. A basic level of knowledge, skill and confidence in measurement is very much an aspect of being "numerate" (Department of Education and the Arts, 1994) and skills in making measurements is of practical importance in everyday life. Developing the ability to make reasonable and appropriate estimations would be an indicator of measurement sense. Following are some suggestions that teachers could use to provide opportunities to develop measurement sense in their students, particularly with reference to area:

1. *Provide a variety of practical applications involving the measurement and estimation of area*

   Measurement is a dynamic activity and learning to measure at all levels of schooling should involve doing (Department of Education & the Arts, 1994). Practically covering a variety of surfaces and physically manipulating units engages students in purposeful experiences and provides a contrast to "traditional" textbook exercises of calculating the area of a number of rectangles on a page.

2. *Measure a variety of objects and shapes, using a variety of units*

   Students need to experience the difficulties associated with the choice of irregularly shaped units for the measurement of area and realisation of the usefulness of standard units comes when students are confronted with confusion in the communication of their measurements involving non-standard units (Department of Education & the Arts, 1994). Measuring irregular objects, such as the starfish, can demonstrate that measurement of area does not always involve neat, regular shapes and enables students to focus on the act of measuring, rather than applying a set formula.

3. *Measurement experiences should be connected to real-life and other mathematics*

   The reasons for measuring should be made explicit to students and embedded in a real-world context. This context should be relevant to the student's real-world, rather than the adult's (McIntosh, 2003). The starfish provided a context for students to find out about area, and monitoring its growth could easily have been extended into other mathematical topics, such as ratio, proportional reasoning, percentages, mass, volume and fractions. The concept of the rectangular array occupies a central role in the understanding of area measurement (Outhred & Mitchelmore, 2000) and the playing cards example (see Figure 5) shows how one student used his knowledge of multiplication to calculate the area of his desk.

4. *Delay the teaching of the area formula*

   In much the same way that mathematics researchers (e.g., Clarke, 2005; McIntosh, 2002) have recommended delaying the teaching of formal algorithms until students have developed a sound number sense, introducing the area formula before students have had opportunities to develop a conceptual understanding of area and to see the usefulness of arrays could be counter-productive to developing sound measurement sense. When students do not

understand the conceptual basis for the formula, then they have difficulty in generalising the procedures they have learned (Outhred & Mitchelmore, 2000). Area and perimeter have traditionally been a source of confusion for students and this may be attributable to the teaching of formulas for both concepts (Van de Walle, 2007) and the tendency for students to confuse these two formulas.

## Conclusions

Area does not need to be a source of confusion for students. When experiences are presented which emphasise a conceptual understanding of area then students have the opportunity to see area as the covering of a surface, rather than as a formula to be calculated. Within the outlined learning sequence, the use of the growing starfish as a stimulus helped to distinguish area from other attributes and involved students in the practice of measuring. Observation of students' behaviour when participating in the various area activities provided information about their understanding of the area concept and "measurement sense." This led to the consideration of the above four suggestions, which may prove useful for consideration by other teachers.

## References


Booker, G., Bond, D., Briggs, J. & Davey, G. (1998). *Teaching Primary Mathematics* (2nd ed.). Melbourne: Addison Wesley Longman Australia.

Clarke, D. (2005). Written algorithms in the primary years: Undoing the "good work"? In J. Coupland, J. Anderson & T. Spencer (Eds), *Making Mathematics Vital* (Proceedings of the Twentieth Biennial Conference of the Australian Association of Mathematics Teachers). Adelaide: AAMT.

Department of Education. (2007). *Tasmanian Curriculum (Mathematics–Numeracy)*. Hobart: Department of Education.

Department of Education and the Arts, Tasmania (1994). *An Overview of the Measurement Strand, Mathematics Guidelines K–8*. Tasmania: Department of Education and the Arts.

Department of Education, Tasmania. (2003). *Essential Learnings*. Hobart: Author.

McIntosh, A. (2003). *Principles for Improving Numeracy in Schools*. Retrieved 12 May 2007 from http://ltag.education.tas.gov.au/effectteach/numerate/mcintosh_print.doc

McIntosh, A. (2002). Approaching computation through mental computation. In M. Goos & T. Spencer (Eds), *Mathematics ~ Making Waves* (Proceedings of the Nineteenth Biennial Conference of the Australian Association of Mathematics Teachers). Adelaide: AAMT.

McIntosh, A., Reys, B. & Reys, R. (1997). *Number Sense (Grades 3–4)*. USA: Dale Seymour Publications.

Mozelle, S. (1989). *Zack's Alligator*. NY: HarperCollins Publisher.

O'Brien, H. & Purcell, G. (2006). *The New Primary Mathematics Handbook*. South Melbourne: Oxford University Press.

Outhred, L. N. & Mitchelmore, M. C. (2000). Young children's intuitive understanding of rectangular area measurement. *Journal for Research in Mathematics Education, 31* (2), 144–167.

Van de Walle, J. A. (2007). *Elementary and School Mathematics* (6th ed.). Boston, MA: Pearson Education Inc.

Zacharos, K. (2006). Prevailing educational practices for area measurement and students' failure in measuring areas. *The Journal of Mathematical Behaviour, 25* (3), 224–239.



Tracey Muir
University of Tasmania
<tracey.muir@utas.edu.au>